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OTTAWA

W. F. KING, C.M.G., LL.D., *Director.*

Vol. II, No. 8

Orbit of the Spectroscopic Binary 1149 Groombridge

BY

W. E. HARPER, M.A.

OTTAWA

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1915

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102-07

ORBIT OF THE SPECTROSCOPIC BINARY 1149 GROOMBRIDGE.

BY W. E. PARPER, M.A.

This star ($\alpha = 6^h 18^m$, $\delta = +56^\circ 20'$, photographic magnitude 5.7) was announced by Adams as a spectroscopic binary from the measures* of three plates taken in the autumn of 1911. These three measures have served very materially in the accurate determination of the period.

Thirty spectrograms of the star have been secured here between February 20, 1914, and March 16, 1915. The single-prism spectrograph with a dispersion of $32.1 \text{ \AA}$ at $\lambda 4325$ was used throughout. The exposure times varied between 30 and 110 minutes, the average for the 30 plates being 78 minutes. In fair seeing, with the Seed 27 plates used, 70 minutes or even less should be sufficient to give a measurable spectrum of this star which is of the A5 type.

The period was discovered from the first half dozen measures taken in conjunction with Adams' early measures and the aim was kept in view to obtain the curve with the least amount of observational data compatible with accuracy. The gaps in the curve were filled up rather slowly as cloudy weather was usually the rule at the particular phase desired. There are three or four plates which have abnormal residuals but further observations at the same phases show that they are purely accidental, as the residuals are both positive and negative, and as no valid reason can be given for rejecting the plates they have all been retained.

Rowland's values of the wave-lengths were used as preliminary, and corrections to these were obtained by the customary method of equating to zero the residuals given by each line from the mean of the plate. Twenty-five plates were used in this connection.

*Astrophysical Journal Vol. 25, page 175.

WAVE-LENGTHS OF LINES USED.

4372.144	4468.870	4290.120	4198.719
4558.799	4415.217	4282.583	4143.788
4549.746	4404.927	4271.645	4101.890
4534.139	4395.286	4260.579	4077.862
4522.907	4351.991	4250.698	4071.861
4520.430	4340.667	4235.991	4063.706
4508.455	4325.907	4233.421	4045.929
4501.503	4307.080	4215.745	4005.402
4481.464	4294.269	4202.118	

MEASURES OF 1149 GROOMBRIDGE.

λ	5948		6008		6016		6016*		6031		6041		6051	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572	+ 39.1	1	- 50.6	1	- 27.3	1	- 25.4	1						
4558													+ 51.1	$\frac{1}{2}$
4549	30.2	1	61.3	1	19.0	1	9.5	1	- 69.6	$\frac{1}{2}$	- 5.6	1	57.4	1
4534					26.1	1	26.0	1	51.5	$\frac{1}{2}$				
4522											- 19.2	1		
4508													60.1	$\frac{1}{2}$
4501									66.7	$\frac{1}{2}$				
4481	35.4	1	77.3	1	11.8	1	12.6	1	43.6	$\frac{1}{2}$	+ 2.6	1		
4415	33.9	1	70.9	1	4.1	1	4.3	1			- 11.8	1		
4404									72.8	$\frac{1}{2}$	- 20.0	1		
4395					13.9	1	14.1	1	48.2	$\frac{1}{2}$	- 11.2	$\frac{1}{2}$		
4352	55.6	1			17.1	1	9.3	$\frac{1}{2}$	62.9	$\frac{1}{2}$	- 2.4	$\frac{1}{2}$	71.8	$\frac{1}{2}$
4340			50.2	1	11.8	$\frac{1}{2}$	20.9	$\frac{1}{2}$			0.0	$\frac{1}{2}$		
4325	43.5	1							61.5	$\frac{1}{2}$	- 4.5	1	51.1	$\frac{1}{2}$
4308	38.6	1	59.7	1	0.0	1			67.6	$\frac{1}{2}$	- 6.9	1	39.6	$\frac{1}{2}$
4294			57.4	1	7.7	1	10.4	1						
4290	36.2	1	53.0	1	7.1	1	8.8	1	51.5	1	- 11.3	1		
4282			66.5	1										
4271	36.0	1	63.2	1	8.1	1	6.7	1	43.5	1	- 15.7	1		
4260							13.1	1						
4250	33.7	1	57.9	1	10.1	1							37.3	$\frac{1}{2}$
4236							9.1	1	63.2	1				
4233	33.9	1	49.5	1	8.7	1	6.1	1	47.3	$\frac{1}{2}$	- 11.3	1		
4215	36.8	1	56.5	1	1.1	1	5.5	1	54.9	$\frac{1}{2}$	- 3.3	1		
4202			47.5	1					77.5	$\frac{1}{2}$				
4143	34.0	1	60.5	1	10.6	1	9.8	$\frac{1}{2}$			+ 0.4	1		
4077			52.9	1	11.5	$\frac{1}{2}$	9.4	1			- 7.5	$\frac{1}{2}$		
4071			62.2	1										
4063			47.1	1	17.5	$\frac{1}{2}$	13.8	1	50.9	$\frac{1}{2}$	- 12.5	1	45.4	1
4045	+ 21.3	1	50.6	1	3.2	$\frac{1}{2}$	0.5	$\frac{1}{2}$	59.5	1	- 6.1	1	+ 41.6	$\frac{1}{2}$
4005			- 56.6	1	- 7.3	1	- 9.3	1	- 71.7	$\frac{1}{2}$				
Weighted mean	+ 34.87		- 57.57		- 11.15		- 10.89		- 58.02		- 8.48		+ 51.57	
V_a	- 21.38		- 24.64		- 24.38		- 24.38		- 23.52		- 21.92		- 20.09	
V_d	- .11		- .12		- .17		- .17		- .15		- .15		- .16	
Curv.	- .28		- .28		- .28		- .28		- .28		- .28		- .28	
Radial Velocity	+ 13.1		- 80.6		- 36.0		- 35.7		- 82.0		- 30.8		+ 31.0	

*Checked by Harper.

MEASURES OF 1149 GROOMBRIDGE—Continued.

λ	6066		6462		6472		6485		6509		6524		6524*	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572			- 70.1	1			+ 35.0	$\frac{1}{2}$						
4549	+ 61.1	$\frac{1}{2}$	78.4	1	- 55.4	$\frac{1}{2}$	26.0	1	-112.0	$\frac{1}{2}$	- 33.6	1	- 31.1	1
4534			69.7	1	45.8	$\frac{1}{2}$								
4522			79.1	1	47.3	1			94.3	$\frac{1}{2}$				
4501									102.2	$\frac{1}{2}$	24.3	1	28.6	$\frac{1}{2}$
4481	54.2	$\frac{1}{2}$			31.6	$\frac{1}{2}$	21.3	$\frac{1}{2}$	94.5	1	26.5	$\frac{1}{2}$	17.0	$\frac{1}{2}$
4468							22.2	$\frac{1}{2}$						
4415											26.4	1		
4404			71.4	1	39.5	1	40.4	1	97.6	$\frac{1}{2}$				
4340											17.5	$\frac{1}{2}$	31.5	$\frac{1}{2}$
4325			69.6	1			35.9	1			40.0	$\frac{1}{2}$	33.8	$\frac{1}{2}$
4308			79.5	1			26.4	1	102.4	1	23.7	1	26.4	$\frac{1}{2}$
4290			77.4	1	41.8	1	23.7	1	104.9	1	26.4	1	30.0	1
4282							32.9	$\frac{1}{2}$	97.7	$\frac{1}{2}$				
4271			79.0	1			25.7	$\frac{1}{2}$			25.7	$\frac{1}{2}$	26.3	$\frac{1}{2}$
4260							25.8	1			30.3	$\frac{1}{2}$	30.5	1
4250	57.9	$\frac{1}{2}$			30.0	$\frac{1}{2}$			88.3	$\frac{1}{2}$				
4236					29.3	1	39.1	$\frac{1}{2}$	102.2	$\frac{1}{2}$				
4233			82.2	1	56.9	$\frac{1}{2}$	38.9	$\frac{1}{2}$	110.9	$\frac{1}{2}$	19.0	1	19.6	1
4215	47.1	$\frac{1}{2}$	81.7	1	32.1	$\frac{1}{2}$	24.6	$\frac{1}{2}$	99.2	1	28.3	1	29.2	1
4198									94.9	$\frac{1}{2}$	22.1	1	25.1	$\frac{1}{2}$
4143	64.7	$\frac{1}{2}$			39.4	$\frac{1}{2}$	31.7	$\frac{1}{2}$			36.3	1	25.9	1
4101											25.5	$\frac{1}{2}$		
4077			72.3	1			23.7	1			28.8	1	24.8	$\frac{1}{2}$
4071			74.8	1			33.8	$\frac{1}{2}$	-109.0	$\frac{1}{2}$	29.5	$\frac{1}{2}$	28.6	$\frac{1}{2}$
4063			68.6	1	42.0	1	29.1	$\frac{1}{2}$			32.3	1	23.9	1
4045	52.7	1	66.8	1	39.0	$\frac{1}{2}$	+ 23.4	1			28.8	1	- 21.9	$\frac{1}{2}$
4005	+ 48.4	$\frac{1}{2}$	- 74.9	1	- 36.6	$\frac{1}{2}$					- 29.1	$\frac{1}{2}$		
Weighted mean	+ 55.66		- 74.72		- 40.69		+ 29.08		-100.59		- 27.00		- 26.84	
V_a	- 17.90		+ 24.90		+ 24.78		+ 24.67		+ 22.78		+ 22.41		+ 22.41	
V_d	- .15		+ .03		+ .03		+ .03		+ .09		+ .06		+ .06	
Curv.	- .28		- .28		- .28		- .28		- .28		- .28		- .28	
Radial Velocity	+ 37.3		- 50.1		- 16.2		+ 53.5		- 78.1		- 4.8		- 4.6	

*Checked by Young.

MEASURES OF 1149 GROOMBRIDGE—Continued.

λ	6547		6563		6575		6605		6621		6632		6658	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572	+ 7.4	1					- 20.5	$\frac{1}{2}$					+ 56.5	1
4549	+ 2.8	1	- 51.9	$\frac{1}{2}$			14.4	$1\frac{1}{2}$	- 8.1	1	+ 18.8	$\frac{1}{2}$	49.5	$\frac{1}{2}$
4534	+ 13.2	1					20.3	$\frac{1}{2}$	20.3	$\frac{1}{2}$				
4522	+ 10.2	1												
4508	+ 1.4	1												
4501									5.2	1				
4481	- 11.8	1	60.0	$\frac{1}{2}$	+ 41.1	$\frac{1}{2}$	25.1	1	17.9	1	12.9	1	42.6	$\frac{1}{2}$
4468													54.5	$\frac{1}{2}$
4415									12.3	1				
4404	+ 4.9	1	66.1	$\frac{1}{2}$					1.2	1	25.8	1	46.4	1
4395							15.8	1						
4352	+ 15.3	1	74.9	$\frac{1}{2}$										
1340	+ 4.2	1			54.9	$\frac{1}{2}$	6.1	$\frac{1}{2}$	37.5	$\frac{1}{2}$	5.1	$\frac{1}{2}$	42.1	$\frac{1}{2}$
4325	+ 13.4	1											58.7	$\frac{1}{2}$
4308	+ 15.0	1			27.5	$\frac{1}{2}$	14.0	1	11.6	1				
4294							17.6	1	14.9	1	7.7	1		
4290	+ 3.3	1			44.0	$\frac{1}{2}$	15.6	1	12.5	1	16.1	1	55.5	1
4271	+ 11.4	1	65.5	$\frac{1}{2}$					14.9	1	0.0	1		
4260	+ 15.1	1			41.4	$\frac{1}{2}$			9.9	1			46.6	$\frac{1}{2}$
4250							24.7	1						
4236											2.7	$\frac{1}{2}$	48.6	1
4233	+ 12.8	1	66.8	$\frac{1}{2}$	38.2	$\frac{1}{2}$	15.0	1	10.6	1	8.1	$\frac{1}{2}$	48.7	1
4215	+ 9.8	1	78.3	$\frac{1}{2}$			27.2	1	17.9	1	7.7	1	47.2	1
4202			63.1	$\frac{1}{2}$					4.3	1	0.8	$\frac{1}{2}$	50.5	1
4143					27.7	$\frac{1}{2}$	16.0	1	17.6	1	15.3	1		
4077	+ 8.3	1	69.5	$\frac{1}{2}$	33.9	1	11.3	$1\frac{1}{2}$			10.9	1	54.7	1
4071	+ 5.6	1	54.9	$\frac{1}{2}$			15.2	1	13.3	1			60.3	1
4063	+ 2.2	1	64.9	$1\frac{1}{2}$	26.8	$\frac{1}{2}$	16.9	1	16.3	$1\frac{1}{2}$	19.9	$1\frac{1}{2}$	42.1	1
4045	+ 6.4	1	- 68.8	$\frac{1}{2}$	+ 31.2	1	17.6	$1\frac{1}{2}$	1.3	1	20.7	$1\frac{1}{2}$		
4005	+ 9.9	1					- 17.3	1	- 13.5	1	+ 17.2	1	+ 42.0	1
Weighted mean	+ 7.56		- 65.44		+ 35.62		- 17.14		- 12.52		+ 12.80		+ 50.08	
V_a	+ 19.91		+ 15.31		+ 13.13		+ 8.05		+ 5.81		+ 4.10		+ 0.01	
V_d	- .02		- .05		- .11		+ .09		- .15		- .11		+ .04	
Curv.	- .28		- .28		- .28		- .28		- .28		- .28		- .28	
Radial Velocity	+ 27.2		- 50.5		+ 48.4		- 9.3		- 7.1		+ 16.5		+ 49.8	

MEASURES OF 1149 GROOMBRIDGE—Continued.

λ	6671		6696		6710		6726		6740		6763		6835	
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572	- 26.8	$\frac{1}{2}$	- 59.4	1										
4558			64.3	1										
4549	39.4	$\frac{1}{2}$	70.5	1	+ 70.8	1	+ 66.6	$\frac{1}{2}$	- 59.7	$\frac{3}{4}$			+ 67.5	$\frac{1}{2}$
4534					50.4	1	33.5	$\frac{1}{2}$	57.8	1				
4522					51.7	1	52.6	$\frac{1}{2}$	69.4	1				
4520					56.6	1	49.8	$\frac{1}{2}$	70.4	1				
4508	31.7	$\frac{1}{2}$												
4501	25.7	$\frac{1}{2}$												
4481	18.7	$\frac{1}{2}$	60.6	1	73.7	1			71.3	$\frac{1}{2}$	+ 4.2	$\frac{1}{2}$	67.6	$\frac{1}{2}$
4468			59.9	1										
4415			67.3	1	49.4	1	60.4	1			21.4	1	62.0	$\frac{1}{2}$
4404					49.7	1								
4395	30.7	$\frac{1}{2}$	62.6	1			54.1	$\frac{1}{2}$	70.2	1	24.6	$\frac{1}{2}$		
4352	20.9	$\frac{1}{2}$												
4340	37.8	$\frac{1}{2}$	63.0	1	59.5	1	39.9	$\frac{1}{2}$	66.1	$\frac{3}{4}$	13.3	$\frac{1}{2}$	75.9	$\frac{1}{2}$
4325	28.2	1	71.8	1	47.5	1			73.5	1			71.5	$\frac{1}{2}$
4308			60.1	1	45.7	1	55.2	$\frac{1}{2}$						
4294					56.8	1					8.9	$\frac{3}{4}$		
4290	35.4	$\frac{3}{4}$	62.2	1	42.9	1			66.2	1			70.5	1
4271	30.4	$\frac{3}{4}$	56.9	1	50.5	1	61.6	1	67.7	1	23.5	$\frac{3}{4}$	72.3	1
4260			58.2	1	44.6	1	47.0	1					59.0	$\frac{3}{4}$
4236	32.9	$\frac{1}{2}$	63.9	$1\frac{1}{2}$	57.2	1	58.4	$\frac{3}{4}$	74.5	1	22.5	$\frac{1}{2}$		
4233	28.4	$\frac{1}{2}$	56.8	$1\frac{1}{2}$	47.5	1	50.3	$\frac{3}{4}$	71.9	$1\frac{1}{2}$	30.1	$\frac{1}{2}$	76.4	1
4215	21.8	$\frac{3}{4}$	64.6	$1\frac{1}{2}$	53.8	1			63.6	$\frac{3}{4}$			69.6	1
4202	26.2	$\frac{3}{4}$			60.8	1					26.6	$\frac{3}{4}$	70.8	$\frac{3}{4}$
4198					50.7	1								
4143			53.8	$1\frac{1}{2}$	42.1	1								
4101							54.2	$\frac{1}{2}$			21.4	$\frac{1}{2}$	53.6	1
4077			55.2	$1\frac{1}{2}$	61.5	1	56.3	$\frac{3}{4}$	71.5	$\frac{3}{4}$	16.6	$\frac{3}{4}$	74.7	$\frac{1}{2}$
4071					57.2	1	39.5	$\frac{1}{2}$			15.0	$\frac{1}{2}$		
4063	24.0	$\frac{1}{2}$	64.4	$1\frac{1}{2}$	57.6	1	50.0	$\frac{3}{4}$	62.0	$1\frac{1}{2}$				
4045	- 26.6	1	65.3	$1\frac{1}{2}$	49.5	1	44.6	1	62.5	$1\frac{1}{2}$	28.4	1	61.6	1
4005			- 61.3	1	+ 52.4	1	+ 45.8	1	- 62.9	1	+ 20.5	$\frac{3}{4}$	+ 63.1	$\frac{1}{2}$
Weighted mean	- 28.42		- 61.80		+ 53.60		+ 51.46		- 66.98		+ 20.22		+ 67.50	
V_a	- 2.48		- 6.46		- 8.10		- 12.55		- 13.96		- 15.02		- 23.60	
V_d	- .07		- .15		- .07		- .10		+ .12		- .11		- .03	
Curv.	- .28		- .28		- .28		- .28		- .28		- .28		- .28	
Radial Velocity	- 31.2		- 68.7		+ 45.2		+ 38.5		- 81.1		+ 4.8		+ 43.6	

MEASURES OF 1149 GROOMBRIDGE—*Concluded.*

λ	6845		6847		6848		6872							
	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.	Vel.	Wt.
4572	- 47.6	$\frac{3}{4}$												
4549	60.0	$\frac{3}{4}$	- 69.8	1			- 8.2	1						
4534							- 3.6	1						
4481	43.9	$\frac{3}{4}$	66.1	1	- 72.9	$\frac{1}{2}$	+ 13.2	$\frac{1}{2}$						
4415	49.5	$\frac{1}{4}$					- 5.5	$\frac{1}{2}$						
4404			68.3	$\frac{1}{2}$	53.2	1	+ 0.7	$\frac{1}{2}$						
4395	43.9	$\frac{1}{2}$					- 9.9	$\frac{1}{2}$						
4352							+ 1.1	$\frac{1}{2}$						
4340	50.6	$\frac{1}{2}$	63.8	$\frac{1}{2}$	65.7	1	+ 9.7	$\frac{1}{2}$						
4325			69.6	1			- 8.8	$\frac{1}{2}$						
4308			71.7	1										
4294							+ 3.2	$\frac{1}{2}$						
4290	59.6	1	59.0	1	62.1	1	- 4.7	$\frac{1}{2}$						
4271	49.4	1	64.4	$\frac{1}{2}$			- 8.6	1						
4260	62.8	$\frac{1}{2}$	61.9	1	70.0	$\frac{3}{4}$								
4250			74.0	1	65.6	$\frac{3}{4}$								
4236			65.2	1	56.7	1	- 5.9	$\frac{1}{2}$						
4233	50.6	$\frac{3}{4}$	56.7	1	54.2	1	- 9.4	$\frac{3}{4}$						
4215	54.2	1	66.6	1	58.7	1	- 6.1	$\frac{1}{2}$						
4202			61.7	1			+ 12.7	$\frac{1}{2}$						
4198			76.5	$\frac{1}{2}$	64.5	$\frac{3}{4}$	+ 1.7	$\frac{1}{2}$						
4143			60.2	1			- 3.8	1						
4101			68.9	1	65.2	1								
4077	43.1	$\frac{1}{2}$	67.0	1	68.1	1	- 12.6							
4071	53.6	$\frac{1}{2}$	64.9	$\frac{1}{2}$	71.0	1								
4063	43.8	$\frac{1}{2}$	65.5	1	62.3	$\frac{1}{2}$	- 9.0	$\frac{1}{2}$						
4045	49.8	$\frac{3}{4}$	- 57.8	1	56.0	1	- 3.0	1						
4005	- 56.1	$\frac{1}{2}$			- 53.7	$\frac{3}{4}$	+ 2.2	$\frac{1}{2}$						
Weighted mean	- 51.82		- 65.23		- 62.05		- 3.32							
V_a	- 23.99		- 24.12		- 24.12		- 24.82							
V_d	- .10		- .06		- .14		- .20							
Curv.	- .28		- .28		- .28		- .28							
Radial Velocity	- 76.2		- 89.7		- 86.6		- 28.6							

The following table contains all the data of the measures. The phases are reckoned from the periastron finally adopted using the period 9.944 days which was determined from a comparison of Mt. Wilson observations with our own. The residuals, O-C, are scaled from the curve representing the adopted elements.

TABLE OF MEASURES OF 1149 GROOMBRIDGE

Plate No.	Observer.*	Date.	Julian Date.	Phase.	Lines.	Weight	Vel.	O-C
1914								
5948	P	Feb. 20	2,420,184.693	7.621	14	7	+ 13.1	- 2.5
6008	C	April 3	226,590	9.742	20	10	- 80.6	- 7.4
6016	H	April 6	229,623	2.831	20	7	- 35.8	-11.0
6031	H	April 13	236,609	9.817	18	7.5	- 82.0	- 7.0
6041	P	April 22	245,628	8.892	18	8.5	- 30.8	+ 8.8
6051	H	April 30	253,612	6.932	9	4	- 31.0	- 5.0
6066	C	May 8	261,570	4.946	7	3	+ 37.3	- 3.6
6462	Y	Oct. 1	407,917	2.133	16	8	- 50.1	+ 2.8
6472	H	Oct. 2	408,921	3.137	14	6	- 16.2	- 3.4
6485	H	Oct. 4	410,916	5.132	19	8	- 53.5	+ 9.5
6509	H	Oct. 20	426,839	1.167	14	6	- 78.1	+ 2.6
6524	Y	Oct. 22	428,843	3.171	20	9	- 4.7	+ 6.5
6547	H	Nov. 2	439,882	4.266	21	10	+ 27.2	+ 1.4
6563	H	Nov. 17	454,875	9.315	12	5	- 50.5	+ 8.0
6575	P	Nov. 23	460,926	5.422	10	4	+ 18.4	+ 1.5
6605	H	Dec. 6	473,675	8.227	18	9	- 9.3	+ 0.1
6621	P	Dec. 11	478,948	3.556	20	9	- 7.1	- 9.8
6632	H	Dec. 15	482,888	7.496	16	8	+ 16.5	- 3.3
6658	C	Dec. 23	490,687	5.351	17	8	+ 49.8	+ 3.4
6671	P	Dec. 30	497,764	2.484	17	7	- 31.2	+ 8.2
1915								
6696	P	Jan. 8	506,859	1.635	21	11	- 68.7	+ 1.0
6710	Y	Jan. 12	510,725	5.501	25	12	+ 45.2	- 2.3
6726	Y	Jan. 23	521,743	6.575	18	7.5	- 38.5	- 1.5
6740	H	Jan. 27	525,475	0.363	17	8.5	- 81.1	+ 3.5
6763	P	Jan. 30	528,739	3.627	14	6	+ 4.8	- 0.3
6835	H	Mar. 4	561,544	6.600	15	7	- 13.6	+ 0.8
6845	Y	Mar. 7	565,625	9.681	16	6	- 76.2	- 4.5
6847	H	Mar. 8	565,568	0.680	21	9.5	- 89.7	- 3.9
6848	H	Mar. 8	565,675	0.787	16	8	- 86.6	- 1.4
6872	Y	Mar. 16	573,687	8.799	22	6.5	- 28.6	+ 7.4

*P=Plaskett, P=Parker, C=Cannon, Y=Young, H=Harper.

MT. WILSON OBSERVATIONS

Date	Julian Date	Phase	Velocity	O-C
1911				
Oct. 30	2,419,340.959	9.127	-55.8	-5.2
Nov. 4	345.923	4.147	+21.2	-0.8
Dec. 11	382.978	1.426	-75.8	+0.1

NORMAL PLACES

	Mean Phase from Final <i>T</i>	Mean Vel.	Weight	O-C		Mean Phase from Final <i>T</i>	Mean Vel.	Weight	O-C
1	0.609	-85.9	.9	-0.1	7	6.662	+38.8	6	-3.7
2	1.470	-72.0	.6	+4.2	8	7.554	+14.9	.5	-3.6
3	2.465	-39.5	.7	+2.7	9	8.227	-9.3	3	-0.8
4	3.307	-8.5	.8	-0.9	10	8.852	-29.9	.5	+6.9
5	4.172	+21.7	.6	-1.5	11	9.674	-74.7	.9	-5.1
6	5.361	+48.8	1.1	+1.1					

Our own observations were grouped on the basis of phase into eleven normal places as above, and, after a few trials, preliminary elements were adopted as follows:—

$$\begin{aligned}
 P &= 9.944 \text{ days} \\
 e &= .07 \\
 \omega &= 160^\circ \\
 K &= 68 \text{ km.} \\
 \gamma &= -13.53 \text{ km.} \\
 T &= \text{J. D. } 2419342.0
 \end{aligned}$$

using these elements and making the transformations,

$$\begin{aligned}
 x &= \delta\gamma \\
 y &= \delta K \\
 z &= K\delta e \\
 u &= K\delta\omega \\
 v &= [1.63633]\delta T
 \end{aligned}$$

we get the following observation equations according to the differential formula of Lehmann-Filhés:—

OBSERVATION EQUATIONS 1149 GROOMBRIDGE.

	Weight.	x	y	z	u	v	$-n$
1	.9	1.000	- 1.064	- .980	- .094	+ .079	+ 0.1=0
2	.6	1.000	- .922	- .115	+ .492	- .563	- 4.2
3	.7	1.000	- .423	+ .938	+ .910	- .936	- 2.7
4	.8	1.000	+ .087	+ .771	+ .964	- .922	+ 0.9
5	.6	1.000	+ .541	- .105	+ .770	- .703	+ 1.5
6	1.1	1.000	+ .901	- .985	+ .231	- .221	- 1.1
7	.6	1.000	+ .825	- .829	- .478	+ .411	+ 3.7
8	.5	1.000	+ .471	+ .702	- .867	+ .818	+ 3.6
9	.3	1.000	+ .075	+ 1.022	- 1.014	+ 1.020	+ 0.8
10	.5	1.000	- .343	+ .652	- .985	+ 1.041	- 6.9
11	.9	1.000	- .825	- .468	- .675	+ .738	+ 5.1

From these were obtained the normal equations:

$$\begin{aligned}
 7.500x - .582y - .433z + .211u - .177v + 1.490 &= 0 \\
 3.919y + .048z + .302u - .308v + 2.577 &= 0 \\
 4.056z + .374u - .375v - 3.454 &= 0 \\
 3.604u - 3.602v - 4.420 &= 0 \\
 3.618v + 4.587 &= 0
 \end{aligned}$$

which resulted in the corrections,

$$\begin{aligned}
 \delta\gamma &= -0.21 \text{ km.} \\
 \delta K &= -0.81 \text{ km.} \\
 \delta e &= +.011 \\
 \delta\omega &= -7^\circ.14 \\
 \delta T &= 0.224 \text{ day}
 \end{aligned}$$

It was feared that owing to the small value of e and consequent similarity of columns for u and v in the observation equations that either ω or T would have to be taken as fixed, but such was not the case and one solution was sufficient, as the difference between the residuals obtained by computing directly and by substituting in the observation equations were all less than 0.2 km. The value of Σprv for the normal places was reduced from 81.0 to 67.8.

The final values then of the elements with their probable errors are the following:—

$$\begin{aligned} P &= 9.944 \text{ days} \\ e &= .081 \pm .027 \\ \omega &= 152^\circ.9 \pm 24^\circ.2 \\ K &= 67.19 \text{ km.} \pm 1.19 \\ \gamma &= -13.74 \text{ km.} \pm 1.39 \\ A &= 62.35 \text{ km.} \\ B &= 72.03 \text{ km.} \\ T &= \text{J. D. } 2419341.776 \pm 0.663 \\ a \sin i &= 9127000 \text{ km.} \end{aligned}$$

The probable error of a plate is ± 3.7 km. per sec. This is somewhat larger than might be expected for a star of this type. If four plates whose residuals seem abnormally large—and in some of these the exposure was unduly prolonged owing to clouds—are omitted, the probable error of a plate becomes ± 2.9 km. per second.

The accompanying graph represents the final elements and the grouped observations.

Dominion Observatory,
Ottawa,
March, 1915.



